

Notes on Some Exotic Species of Ectoparasitic Trematodes.

By

Seitaro Goto,

Professor in the First High School, Tokyo.

With Plates XX & XXI.

The present notes contain the substance of a paper read by me at a sectional meeting of the Third International Congress of Zoologists held in Leyden (1895), together with descriptions of a few additional species. Some of these results have been communicated to my friend Dr. G. Saint-Remy of Nancy and incorporated by him in his recently published "*Complément du synopsis des Trématodes monogénèses*" ['98]. The following gentlemen have materially helped me in various ways, and I wish here to express my best thanks to them: Drs. C. W. Stiles and A. Hassall of Washington, Prof. A. E. Verrill of New Haven, Prof. F. J. Bell of the British Museum, and Dr. G. Saint-Remy of Nancy. I must also note my deep obligation to Prof. A. Agassiz for enabling me to study in his laboratory in Newport, R. I., where many of the new species described in the following pages were collected. To the authorities of Harvard University and of the U. S. Fish Commission Laboratory

in Woods Holl, Mass., my sincere thanks are due for affording me the use of a table in the latter Laboratory.

Phyllonella hippoglossi (O. F. Müller).

This is the *Epibdella hippoglossi* of P. J. van Beneden and of Monticelli. In his work of 1888, the latter author distinguishes the present genus from *Epibdella*, but in his later paper ['91, p. 125] he unites the two genera into one. According to my own observations these two genera are very closely related to each other, but they are distinguished by the fact that *Epibdella* is provided with well developed anterior suckers with distinct borders, while *Phyllonella* is destitute of any anterior sucker in the true sense of the word, the anterior suckers being replaced by a membranous projecting portion of the body, in which lie innumerable unicellular glands (fig. 1). The figures of van Beneden and Monticelli may perhaps lead one to infer that these authors believed to have had before them true suckers with distinct borders; but their descriptions clearly show that this was not the case. Van Beneden says, "Ils ont la forme d'un coussinet; il n'y a point de bord libre ni d'excavation au milieu; on ne distingue point de fibres rayonnées ou circulaires dans ses parois, et c'est à peine si on peut même dire qu'ils forment saillie. Ce sont des organes qui prennent leur développement seulement dans d'autres Vers et qui sont ici dans un état rudimentaire" ['61, p. 22]. Monticelli also has recognized this fact and proposed the name of "pseudoventose" for the organs in question ['91, p. 106]. We can, however, scarcely speak of the "organs" (in the plural), since the glands above referred to are present on the dorsal side uniformly in all parts of the membranous portion (fig. 2), and their segregation in two

groups is only indicated by the presence of a notch in the posterior border of the area occupied by the glands (fig. 1). The apparently distinct borders observed and figured by the preceding authors are caused by the presence of the numerous outlets of the unicellular glands, which open close to each other on the lateral portions of the ventral side of the membranous portion and are totally absent from the median groove separating them (fig. 2). These outlets contain, especially in their terminal parts, more or less secretion of a granular appearance having a great affinity for stains, and thus impart a dark aspect to the area occupied by them, whether in surface view or as a transparent object, or whether stained or not. The cells themselves are goblet shaped, the necks are very long, and the cell body is either finely or coarsely granular, or is filled with large vacuoles, according to the stages of secretory activity.

The posterior sucker is provided with three pairs of chitinous hooks of the form shown in fig. 4, which represents those of the right side as seen from the ventral surface. The most anterior piece is very stout and nearly straight and is sharply pointed at both ends; its length is 0.772 mm. The middle piece is much more slender and strongly recurved; it is very long, being 1.38 mm. The posterior piece is exceedingly small and consists of two portions, the basal flat portion somewhat like the scales of *Lepidoptera*, and the distal hook like portion; the total length is only 0.099 mm. Besides these three pairs of hooks there is, imbedded in the mesenchyma, usually a group of chitinous granules of an irregular shape on the inner side of the anterior piece.

According to the statements of van Beneden and Hesse ['64, p. 71] and of Cunningham ['90, p. 94] there are only two

pairs of chitinous pieces in the posterior sucker of *Ph. soleae*, but this difference can not be regarded as of generic value. I am, moreover, inclined to suspect that the most posterior pair were overlooked by these authors, owing to their exceedingly small size as compared with the other pairs.

A number of gigantic cells are always associated with the anterior parts of the chitinous hooks. They are situated strictly symmetrically on either side of the posterior sucker, so that a description of one side will serve for both. As shown in fig. 5, two cells are associated with the most anterior piece and five with the middle piece. They are all of an irregular form, have a coarsely granular protoplasm, and send out processes, which are closely associated with the muscular fibres attached to the chitinous pieces. As the material at my disposal was very old and not sufficiently well preserved, I could not make out the intimate connection of these protoplasmic processes with the surrounding tissues. But there is no doubt about their close contiguity to the muscular fibres of the chitinous pieces on the one hand and their independence from the network of nervous tissue, which is clearly visible in the sucker and a small portion of which is reproduced in fig. 7. In fact the nervous network is situated on a different level in the sucker, being confined more to the deeper layer, while the gigantic cells under consideration are situated close to the ventral surface, just inside the chitinous pieces (fig. 6). In view of these considerations and comparing them with the beautiful results obtained by Bettendorf ['97] and others on the muscle cells of flatworms I think I am not going much amiss in regarding the cells in question as myoblasts, developed in connection with the strong musculature of the chitinous pieces. I should recommend their further study

to the students who can command fresh specimens of the present species, since these cells will, in my opinion, form, from their gigantic size and the stoutness of their processes, especially fit objects for the application of the methylene blue or Golgi method. For instance, the fusiform cell on the left side of the anterior chitinous piece shown in fig. 5, measures $74\ \mu$ across. Besides the cells shown in fig. 5, I have observed a few similar cells in their vicinity, but they seemed to me inconstant both in position and number.

The descriptions of the genital organs given by van Beneden ['61] and Cunningham ['90] require some comments and corrections. The general arrangement of these organs are very similar to that of the allied genus *Epibdella*, but presents some peculiar features. There are two genital openings, the common genital pore and the vaginal pore (fig. 3), the former being situated on the left side of the body close to the lateral margin, and directly behind the hind end of the anterior membranous portion of the body, and the latter lying slightly internal to the former and at a short distance behind it. The vaginal canal proceeds obliquely backward and opens into the yolk reservoir just as in *Tristomum* and *Epibdella*, and bears no seminal receptacle on its course. It has been observed by van Beneden ['61, p. 34] and designated in his figure ['61, pl. III, fig. 1] as a "glande s'ouvrant à côté de l'orifice des organes sexuels," of the connection and function of which, however, the author was not quite sure. Cunningham ['90] also describes a "vesicula seminalis" in connection with the vas deferens; but it can not be anything else than the vagina. Again, van Beneden speaks of "deux vésicules séminales" ['61, p. 29]. Here, however, I must point out the discrepancy of terminology between his text and figure.

In the former he calls the prostate gland and the internal cavity of the penis "vésicules séminales," and the receptaculum seminis "vésicule copulative" [p. 32], while in the explanation of the figure relating to the point [pl. III, fig. 1] he calls the latter "vésicule séminale interne," and the prostate gland alone "vésicule séminale."

The penis is a hollow, pear-shaped body with a comparatively thin wall, lying in the expanded blind end of the genital atrium. The terminal portion of the vas deferens enters its wall at its hind end, and expanding slightly, forms a sort of seminal reservoir, as in many species of *Tristomum*. The internal cavity of the penis communicates with that of the prostate gland by means of a short narrow canal, and is usually filled with a finely granular mass, the secretion of the prostate gland.

The prostate gland is an irregularly rounded, vesicular organ lying directly behind the penis. In the specimens examined by me the internal cavity was almost completely filled with a finely granular mass staining deeply in carmin. The structure of its wall could not be made out in my sections, but I think I may safely assume that the granular mass just referred to has been secreted by the protoplasmic wall.

The receptaculum seminis lies in the proximal portion of the oviduct at a short distance from the ovary, and is, as correctly observed by van Beneden, a vesicular organ consisting of five to six lobes, and opening directly into the oviduct. Between it and the ovary, but nearer the former, the oviduct receives the unpaired yolk duct coming from the yolk reservoir, from which it originates on the dorsal side a little towards the anterior, and proceeds slightly backward on its way to the oviduct. In most species of *Tristomum* and *Epibdella* the shell glands open into

the oviduct directly behind the ootyp; but in the present species the latter lies at a considerable distance forwards, about half way between the openings of the shell glands and the opening of the uterus into the genital atrium. The latter is a slender canal-like cavity and is expanded only at its posterior end, where it contains the penis.

Epibdella sciencæ P. J. v. Beneden.

The following notes on this species are based on a single mounted specimen in possession of Dr. Stiles of Washington, who has kindly permitted me to study it. The specimen is stated to have come from Dr. P. Sonsino of Pisa and to have been found on *Sciæna umbra*.

The specimen (fig. 8) is very small, being only 13 mm. long, but the genital organs appear to be mature, as the vas deferens and the seminal receptacle are filled with spermatozoa.

As stated under the foregoing species, the genus *Epibdella* is distinguished from it by the possession of well developed anterior suckers. These are circular in the present species and are roughly one third as large as the posterior sucker in diameter. The latter is armed with three pairs of hooks, which have been well described by van Beneden ['61]. The most anterior piece (fig. 9) is considerably larger and stouter than the others, and is 0.72 mm. long; its posterior end is bifurcated, and at its middle it has a broad triangular process on one side, which is directly continued into one of the branches of the bifurcation. The middle piece, as measured on my specimen, is 0.30 mm. long; but I suspect that its posterior portion is wanting. The most posterior piece is provided with a very distinct hook at its hind end. The anterior portion is lamellar

and is divided into two by a deep incision. It is 0.22 mm. long.

The general arrangement of the genital organs is essentially similar to that of other species of the genus. The prostate gland, the "vésicule séminale" of v. Beneden ['61, p. 35], is oval, and in my specimen is entirely filled with a coarsely granular mass, which stains deeply with carmin.* It opens into the cavity of the penis by means of a very short duct traversing the wall of the penis. The latter is comparatively long and slender, and tapers gradually towards its apex. The vas deferens undergoes convolutions similar to those found in other species, and opens into the cavity of the penis at a point removed from its proximal end about one third of its total length. Van Beneden speaks of a "vésicule de dépôt" at the point of union of the two vasa efferentia ['61, p. 35]; but in my specimen none could be observed. The ootyp is very distinct and is situated close to the penis; the uterus is consequently very short, and the oviduct proportionately long.

One peculiarity of this species lies in the possession of a single genital pore for both the common genital pore and the vaginal opening of other species. In all the other species of this genus, and in *Phyllonella* and *Tristomum*, the vaginal opening is separated from the porus genitalis communis, and the union of the two must be looked upon as of rather rare occurrence. The vaginal canal presents near its posterior end a swelling representing the receptaculum seminis, from which a short canal leads into the yolk duct. There was no yolk reservoir in my specimen; but this can not be regarded as proving its total absence, since its formation is more or less dependent on the accumulation of the yolk cells.

*The specimen was stained with acid carmin.

Tristomum leve Verrill.Syn.—*Tristomum histiophori* Bell. ['91.]*Tristomum ovale* Goto. ['94.]

In the original description of *Tristomum ovale* ['94, pp. 241-244] I expressed the suspicion that it might prove identical with the *Tr. histiophori* of Bell ['91], and in a sectional meeting of the Third International Congress of Zoologists held in Leyden, I stated that *Tr. ovale* Goto must be regarded as a synonym of *Tr. leve* Verrill ['75, p. 80; '85, pl. 43]. This latter conclusion was based on an examination of a type specimen of *Tr. leve*, which was kindly given me by Prof. Verrill. Subsequently, on my visit to the British Museum, Prof. Bell was so kind as to give me some specimens of *Tr. histiophori*; and a comparison of these specimens with each other and with those of *Tr. ovale* has brought to light some additional facts which further elucidate the affinity of these forms.

The specimen from Prof. Verrill is rather old, but the important points can all be made out. The external features of the body as well as the arrangement of the internal organs are exactly similar to what I have observed in *Tr. ovale*, except in two points; viz. the length of the hooks in the posterior sucker and the presence of numerous chitinous corpuscles on the dorsal surface of the body. These corpuscles were noticed by me from the first, but as there was a crusty precipitate on the specimen before mounting, I was not quite sure whether these corpuscles were really chitinous structures belonging to the worm or whether they were not extraneous encrustment. The presence of similar corpuscles in the specimens of *Tr. histiophori* has, however, convinced me that they were integral parts of the worm.

They are mostly confined to the marginal part of the body, but are also present, although sparsely, on the more internal parts. They are somewhat similar to the chitinous corpuscles of *Tr. coccineum* and *Tr. mola*. Each corpuscle consists, namely, of a basal rounded portion imbedded in the investing membrane of the body, and a projecting portion which is either bi-, tri-, or quadricuspid (fig. 10). They are of various size, the smallest ones being about 10 μ across at the base and the largest ones being three times as large. They do not form transverse rows, as in *Tr. coccineum*, nor do they form such a regular longitudinal row on either side of the body, as in *Tr. sinuatum* and *Tr. biparasiticum*, but are scattered singly in the marginal portion of the body, on the dorsal side. The most external ones, however, tend to form a longitudinal row. It is needless to remark that these chitinous corpuscles are entirely absent in the specimens of *Tr. ovale*.

The second point of difference between the forms under consideration lies in the difference in size of the hooks in the posterior sucker. In the specimen of *Tr. leve* they measure 0.63 mm. in length, while in *Tr. histiophori* they are 0.85 mm. long. In *Tr. ovale* they are 0.91 mm. This difference between *Tr. histiophori* and *Tr. ovale* may perhaps be attributed to errors of observation, but the difference between *Tr. ovale* and *Tr. leve* can not be so accounted for. With all this difference in size, the hooks are remarkably similar in form in all the three forms.

With the facts above detailed in mind I propose to amalgamate the three species, *Tr. leve* Verrill, *Tr. histiophori* Bell, and *Tr. ovale* Goto into one, which, agreeably to the law of priority, must be called *Tristomum leve* Verrill, and to distinguish

the form described by me as *Tr. ovale* as var. *inermis*, and the forms described by Verrill and Bell as var. *armata*.*

Hexacotyle thunninæ (Parona et Perugia).

This is the *Octocotyle thunninæ* of Parona and Perugia ['89]. An examination of a mounted specimen from Prof. Parona in possession of Dr. Stiles, who has kindly allowed me to study it, proves beyond doubt that it must be referred to the genus *Hexacotyle*, as diagnosed in my "Studies" ['94]. The body is, generally speaking, lanceolate, narrow and pointed anteriorly, but broad and tongue shaped posteriorly (fig. 13). The whole body may be divided into three portions: the most anterior slender portion, which is very short and occupies only a little over one eighth of the whole length; this is followed by a broadened portion occupying roughly about one third of the rest; then follows a portion of nearly uniform width, which is, however, slightly expanded at the posterior end. There are four pairs of semi-ellipsoidal posterior suckers arranged on the convergent sides of the tongue like portion. They are nearly of the same size, and the most posterior pair are only slightly smaller than the rest, the longer diameter being 0.22 mm.† as against 0.36 mm. of the first two pairs. In all the other species of *Hexacotyle*, the most posterior suckers are considerably smaller than the others; and the peculiarity just mentioned is alone enough to establish the present species. Each sucker is provided with

*Setti, in his recently published paper ['99] which I received after the above had been written down, has also come to the conclusion that my *Tr. ovale* is identical with *Tr. leve* Verrill and *Tr. histiophori* Bell. As to the opinion of the same writer on the synonymy of *Tr. rotundum* and *Tr. coccineum*, I can only agree with him; the differences between the two, enumerated by me ['94, p. 247] are too trivial to be of specific value.

†The average of the measurements on the two sides.

three chitinous pieces, one somewhat large, saddle-shaped piece in the middle, and two smaller pieces at the two ends (fig. 14). There are two pairs of hooks at the posterior end of the body, between the hindmost pair of suckers. The external pair are considerably larger, and the hook is provided with a lateral barb-like process at the middle; they measure 0.128 mm. in length (fig. 15 *b*). The internal hooks are very slender and are slightly curved at the middle; they are only 0.048 mm. long.

The common genital aperture is situated near the end of the anterior slender portion of the body, and the vaginal opening at a short distance behind it, at the boundary between the anterior two portions of the body. The vaginal opening is armed with two chitinous bodies forming a pair, bearing numerous denticuli on the inner side. In their paper of 1889 Parona and Perugia mistook the vaginal opening for the common genital aperture, and although I have not access to their paper of 1892, it appears from the resumé of Saint-Remy, that they repeat the same error in their note on *Hexacotyle thynni* [Saint-Remy, '98, p. 556], and mistake the common genital pore for the vaginal opening.

The ovary could fairly be made out in Dr. Stiles' specimen, and is a triangular mass situated in the median line, at the hind end of the second expanded portion of the body.

Octocotyle seombri (Kuhn).

In my "Studies" ['94, p. 206] I expressed the suspicion that the two species described by me as *O. major* and *O. minor* might have been confounded and regarded as a single species by European writers. Relying, however, on the figures of Parona and Perugia ['89] I then concluded that my suspicion

was not well founded. While I was working in Mr. Agassiz's laboratory in Newport I collected some specimens of *Octocotyle* from the gills of the mackerel (*Scomber scomber*), and an examination of these has shown that they belong to my *O. major*, having five pairs of penis hooks and a single pair of hooks at the posterior end of the body, the forms of these hooks as well as the other characters perfectly agreeing with those of *O. major*. This has revived the suspicion expressed in my "Studies," and a comparison of the figures and descriptions of Dujardin, van Beneden, and Parona and Perugia has led me to reverse my former conclusion and to recognize two species in the published descriptions of *O. scomberi*. Thus, Dujardin as well as Parona and Perugia give the number of penis hooks as twelve; again, according to Parona and Perugia ['89] there are two pairs of hooks at the posterior extremity of the body, of which the internal pair are considerably smaller than the other. The figures of these hooks given by the last named authors are, indeed, totally different from those of *O. minor*, and I was led by them to the conclusion stated in my "Studies;" but a careful study of the description of Parona and Perugia leads me to infer that the words "fig. 3," referring to the hooks in question, must be a *lapsus calami*, and that the figures must represent the penis hooks. Mark, on this point, the words describing these hooks, "quelli del paio superiore sono piu esterni, piu grossi e *con due denticoli basali*." It appears, then, that Dujardin and Parona and Perugia had before them *O. minor*. It must be remarked, however, that the dimensions given by Dujardin correspond better to those of *O. major*. Van Beneden and Hesse, on the other hand, give the number of penis hooks as ten, which is characteristic of *O. major*.

It appears, therefore, that two species must be recognized under the name of *O. scombri*, viz., *O. major* Goto and *O. minor* Goto. Unfortunately the original paper of Kuhn ['29] is not accessible to me, and I can not decide to which species his specimens should be referred. If, however, his description and figures should prove insufficient to decide the present question, I should propose to retain the name of *O. scombri* for my *O. major*.* It goes without saying that the former name should then also appear as a synonym *pro parte* of *O. minor*.

It may be added in conclusion that the posterior hooks of the specimens of *O. major* from the mackerel taken off Newport, measured 0.112 mm., a figure almost coinciding with the one obtained for *O. major* ['94, p. 203].

Polystomum Hassalli n. sp.

(Pl. XXI, figs. 16 & 17).

Total length of the body 1.5 mm., body proper ovate; adhesive disc hexagonal, the hemispherical suckers occupying the angles of the hexagon, and each with a minute hook in the centre (fig. 17 *b*); with three pairs of hooks between the most anterior pair of suckers, and two pairs between the most posterior, these hooks and those in the suckers being all of the same form and measuring 0.33 mm. in length. The larger hooks between the most posterior suckers bifurcated towards the base, without any lateral process, measuring 0.125 mm. in length. Anterior sucker large. Oesophagus wanting; intestine bifurcated, tubular, without lateral branches, the two legs ending independently at the front end of the adhesive disc, and together enclosing an

* Following Articles 35 and 36 of the "Règles de la Nomenclature" adopted by the two International Congresses of Zoology held in Paris and Moscow.

oval area, in which lie the ovary and the testis. Common genital pore lying midway between the front end of the body and the front end of the adhesive disc. I counted 15 penis spines, which are straight and bear a wing-like process at the middle, and are 0.028 mm. long; but as their number in other species is always even, I think that there are 16 in the present species. Testis irregularly ovoidal, large, with lobulated margins, nearly filling up the posterior half of the area enclosed by the intestinal branches. Ovary small, somewhat comma-shaped in the ventral aspect, sometimes lying in the right half of the body and sometimes in the left half. The oviduct arises from the smaller end of the ovary and proceeds obliquely forward, and opens into the uterus, which is situated directly behind the common genital pore. Vaginal openings lateral, without papillæ, midway between the front and hind extremities of the body proper, the two vaginal canals directed almost straight across the body and meeting in the median line. Genito-intestinal canal slightly behind the vagina, on the same side as the ovary. Vitelline lobes not very numerous, separated from one another, mostly confined to the lateral portion of the body, but also present in the median portion behind the testis.

Here it may be in place to make a remark on the type specimen of Leidy's *Polystomum oblongum* from the urinary bladder of the food terrapin (*Pseudemys rugosa*), which I was enabled to examine through the kindness of Dr. Stiles. At my suggestion the specimen was mounted; but it was in a rather miserable condition, the hooks of the adhesive disc being all gone, except those in the suckers. Enough could, however, be made out to prove that the species represented by it was not the *P. oblongum* of Wright ['79]. There were, namely, 16

penis spines, which were *all of the same size and form*, measuring 0.66 mm. in length. Each spine consisted of two portions, a distal awl-shaped part with an expanded base, and a handle-like part consisting of two slender filaments (fig. 18). In *Polyst. oblongum* Wright there are 16 penis spines, but these are alternately small and large. Hence, Leidy's *P. oblongum* is not identical with *P. oblongum* Wright; nor can it be referred to the species here described, the form of the penis spines being very different. It must be a new species; but it would be useless to name it in the absence of any adequate description.

The new species here described was found by Dr. A. Hassall of Washington in the urinary bladder of *Kinosternon pennsylvanicum* in Bowie Prince George County, Md. My best thanks are due to Dr. Hassall for kindly giving me several of the specimens.

Microcotyle pomatomi n. sp.*

(Pl. XXI, fig. 27).

Body symmetrical, elongated; length 4 mm., of which nearly the posterior one-third bears about 70 suckers on either side and does not contain any internal organs, except the terminal portion of the intestine; the sucker-bearing portion projecting a little in front on the ventral side. Oesophagus of moderate length, terminating a little behind the common genital

* I may take this opportunity of replying to Drs. Parona and Perugia, who criticise me for "neglecting," in my descriptions of the new species of *Microcotyle*, the chitinous armature of the genital atrium, which to them constitutes "il carattere veramente differenziale delle varie specie" ['96, p. 3]. If, now, one turns to my "Studies," to which the above criticism refers, one will see that I devoted no less than four full pages to the description of the genital atrium, including the spines, of *Microcotyle* in the anatomical part, and then again gave the points peculiar to each species in the systematic portion. I must at the same time express a warning against taking any *single* character, however decisive it may appear to be at the time, as the criterion for determining species. The agreement of a single character does not always prove identity of species.

pore; intestine with numerous lateral, bifurcating branches both on the inner and outer sides, terminal portion without lateral branches and projecting beyond the vitellarium, that of one side slightly longer than the other. Common genital opening a little in front of the hind end of the oesophagus; genital atrium spacious, armed with slightly recurved conical spines varying in length from 13μ to 16μ . Ovary irregularly S-shaped in the dorsal aspect, presenting a convex border anteriorly, and with the posterior end folded several times on itself. The oviduct arises on the right side, and proceeding obliquely backwards and mediad to near the front end of the testes, turns forwards and is continued into the ootyp; no seminal receptacle was observed on its course. Vitellaria almost completely enclosing the intestine and its lateral branches, but leaving the front and hind ends free. Paired yolk-ducts arising a little in front of the middle of the body proper, uniting in the median line at the point corresponding to the middle of the ovary; the single yolk duct thence proceeding posteriorly and opening into the oviduct close to where the latter turns forwards to become the ootyp. Vaginal opening dorsal and median, as much behind the posterior end of the oesophagus as the common genital aperture is before it; vaginal canal long and dividing into two only at its hind end just before opening into the paired yolk-ducts. Testes about 50, small, extending from the hind end of the ovary to near the hind end of the body proper.

Habitat.—Gills of blue-fish (*Pomatomus saltatrix*).

Loc.—Newport, R. I.

Microcotyle stenotomi n. sp.

(Pl. XXI, fig. 28.)

Body symmetrical, narrow, 2.5 mm. long, of which the

sucker-bearing portion occupies about one-third; the latter slender and narrow and joined to the body proper by a slender stalk-like portion, with about 46 pairs of minute suckers; the anterior end of the sucker-bearing portion projecting on the ventral side somewhat in front of the point of union with the body proper. Oesophagus rather short, the main intestinal branches with numerous secondary branches on the outer side, which bifurcate only once or twice, and with very short diverticula on the inner side; one of the main branches extends backwards further than the other. Common genital opening on the same level as the hind end of the oesophagus; genital atrium moderately spacious, armed with numerous very small, conical, slightly recurved spines, 4-5.6 μ long. Ovary incompletely S-shaped in the dorsal aspect, presenting an inverted V-shaped border anteriorly, the hind half very slender, and the posterior somewhat thickened end folded once or twice on itself. Oviduct arising on the right side, and proceeding obliquely backwards and mediad till the hind end of the slender portion of the ovary, and then turning forwards to become the ootyp; bearing a distinct receptaculum seminis at the middle of its course. Vitellaria extending from a short distance behind the beginning of the intestine to the hind end of the shorter of the two main branches. Paired yolk-ducts arising at a point removed from the front end of the ovary $1/5$ as much as the common genital opening, uniting on the same level as the middle of the ovary, and the single yolk-duct thus formed opening into the oviduct close to the ootyp. Vaginal opening dorsal and median, midway between the front end of the body and that of the ovary; vaginal canal tolerably long and dividing into two only

a short distance before opening into the paired yolk-ducts. Testes only about a dozen, small.

Habitat.—Gills of scup (*Stenotomus chrysops*).

Loc.—Newport, R. I.

Microcotyle hiatulæ n. sp.

(Pl. XXI, fig. 29.)

Body symmetrical, anteriorly blunt, 3.5 mm. long, of which the posterior one-fourth bears about 23 pairs of suckers on either side; the sucker-bearing portion projecting slightly in front on the ventral side. Oesophagus of moderate length; the main intestinal branches of unequal lengths, one of them extending much more backwards into the sucker-bearing portion of the body, with numerous bifurcating branches on the inner and outer sides, those of the former being, however, very short. Common genital pore a short distance in front of the hind end of the oesophagus; genital atrium with numerous conical, slightly recurved spines, ranging in length between 15μ and 18μ . Ovary somewhat like a hastily written capital E of the current hand, presenting a very convex border in front. The oviduct arises on the right side, and undergoes one or two windings on its course obliquely backwards and towards the left side to the posterior end of the ovary, where it turns forwards to become the ootyp. Vitellaria extending from near the hind end of the oesophagus to the hind end of the body proper. Paired yolk-ducts arising about one-fourth as much in front of the ovary as the common genital opening, and uniting in the median line a short distance in front of the ootyp; the median yolk-duct opening into the oviduct at a short distance from the ootyp. Vaginal opening median and dorsal, as much behind the front end of the intes-

tine as the common genital opening is in front of it; vaginal canal tolerably long and dividing into two when it has proceeded a little over one-half of the distance between the vaginal opening and the front end of the ovary. Testes large, about 15 in number, extending from the hind end of the ovary to a little in front of the posterior end of the vitellaria.

Habitat.—Gills of black-fish (*Hiatula onitis*).

Loc.—Newport, R. I.

Microcotyle longicauda n. sp.

(Pl. XXI, fig. 30 & 31.)

Body symmetrical, elongated, pointed at the two ends, 6 mm. long, the ratio of the sucker-bearing portion to the body proper being 7:11; number of suckers about 120 on either side. Oesophagus moderately long; the main intestinal branches of equal length on the two sides, with numerous bifurcating, lateral branches on the inner and outer sides, except in the most posterior portion extending beyond the vitellaria, the branches of the inner side being much shorter than those of the outer. Common genital opening a short distance in front of the hind end of the oesophagus. Genital atrium very spacious, and divisible into two portions, an anterior and a posterior, the latter being less capacious; atrial spines conical and slightly recurved, arranged in two groups (fig. 31) corresponding to the two portions of the atrium just mentioned, and the posterior group being again divided in the median line. The spines of the anterior group range in length between 13μ and 16μ , but those of the posterior group are much shorter, being 9μ or less. Ovary like the anterior two-thirds of an S in shape, presenting an almost straight border in front. Oviduct arising on the right side and

proceeding slightly backwards but mostly towards the left side to the level of the hind end of the ovary, where it turns forwards and becomes the ootyp. Vitellaria extending from near the front end of the intestine to near the hind end of the body proper. Paired yolk-ducts arising in the middle of the body proper and uniting in the median line at the front end of the ootyp; the single yolk-duct opening into the oviduct at a short distance from the ootyp. Vaginal opening dorsal and median; vaginal canal long and dividing into two just before opening into the paired yolk-ducts. Testes small and about 55 in number, extending posteriorly to a short distance in front of the hind end of the vitellaria.

Habitat.—Gills of weak-fish (*Cynoscion regale*).

Loc.—Newport, R. I.

Acanthocotyle Verrilli n. sp.

(Pl. XXI, figs. 25 & 26.)

The genus *Acanthocotyle* was founded by Monticelli in 1888 ['88, p. 97], and two species were subsequently described by him ['90, p. 2-3].*

* While the present paper was awaiting for the press I received the first number of the "Archives de Parasitologie, t. ii," in which is contained a paper by my friend, Prof. F. S. Monticelli, on the present genus ['99]. In it the author describes a new species, the third of the genus, named *A. oligoterus*. That the species here described can not be identified with the above named one is, however, beyond doubt, as may be seen from a comparison of the following text with the description of Monticelli.

There is another point on which I wish to make a remark, viz. the position of the genital openings. The plates to accompany Monticelli's paper is unfortunately not yet published, but it appears from his descriptions that in all the European species the male and vaginal pores lie in the median line, and the female pore on the left side close to the lateral margin. As stated in the text, my observations were made on a single mounted specimen, and although I believe them to be in the main correct, still examination of serial sections is in all similar cases exceedingly desirable. I must therefore leave my statements to be confirmed or rectified by somebody having sufficient material.

In the new species the body is of almost uniform breadth, and presents a slightly concave border anteriorly. There is also a distinct constriction at the level of the pharynx. The posterior sucker is large and circular, and has 34 radii consisting of numerous hollow chitinous hooks. These radii leave the central area of the sucker free, and the most posterior four or five pairs gradually decrease in length backwards, so that there is a backward extension of the central area. The longest radii consist of about eleven hooks and the shortest of only four. Each hook is hollow and strongly curved at the middle, and consists of a thickened basal portion and a slightly slenderer distal portion terminating in a solid claw (fig. 26). The internal cavity of the hook is filled with a finely granular substance, and a single oval nucleus containing a nucleolus could always be observed near the basal end. At the hind end of the posterior sucker there is, in the median line, a roundish appendage (*app. post.*) armed with filiform chitinous hooks somewhat like the upper part of an interrogation point. I can not exactly state the number of these hooks, but I counted more than twenty. Monticelli speaks of two anterior suckers; but there is none in the new species, and their places are occupied by two invaginations of the investing membrane of the body, in which open numerous unicellular glands. The invaginations are very narrow and deep, and appear like slits in the mounted specimen. Each gland cell is goblet-shaped and has a long neck which is much thickened just before opening into the invagination above mentioned. There is one compact group of these gland cells for each invagination, lying between the pharynx and the lateral margin of the body; their necks run in a bundle, and their thickened terminal portions form a pear-

shaped mass. The latter was probably mistaken for a sucker by Monticelli; for I find an exactly similar arrangement in *A. Lobianchoi*, a few specimens of which have been kindly sent me in exchange by Prof. Monticelli.

The oesophagus is exceedingly short, and the simple intestinal branches terminate a little in front of the centre of the sucker.

The terminal portions of the genital ducts could not be satisfactorily made out in the single specimen at my command; and although the results of my observations differ in some important points from those of Monticelli, I believe they are in the main correct.

The ovary is a spherical body lying in the median line at the hind end of the anterior one-third of the total length of the body. The oviduct starts from the anterior end of the ovary and presents an enlargement at the outset, which is perhaps the ootyp. If this is so, then the whole remaining portion of the duct must be called the uterus; this undergoes some convolutions, and proceeding obliquely towards the right side, opens into the hind end of a shallow genital atrium in the margin of the body, in the constriction mentioned above. There are about 37 testes as seen from the ventral side; and the vas deferens starts on the right side, between the ovary and the intestine. It then proceeds forwards, and just behind the intestinal arc, describes a loop, and after undergoing some additional convolutions, opens finally into the genital atrium at its front end. There are several enlargements in the course of the vas deferens. On the right side of the body just in front of the excretory vesicle there is another cavity of a spherical form. This, I believe, is the seminal receptacle, and the canal proceeding anteriorly from it and opening into the genital atrium between the uterus and the vas

deferens, must be the vagina. The vitellaria are quite extensive and are almost entirely confined to the lateral portions of the body external to the intestine.

Habitat.—On the body of a skate, above and below.

Loc.—Off Cape Cod. From Prof. Verrill, to whom my best thanks are due.

Dionchus Agassizi n. g. n. sp.

(Pl. XXI, figs. 19-24.)

The body is elongated, and the breadth gradually decreases backwards. The total length is 2 mm. as measured on a somewhat contracted specimen. The anterior end is triangular, with a pointed apex, and there is a shallow constriction just behind the pharynx. The posterior end terminates in an elliptical sucker, whose internal surface is divided into ten areas by as many radial ridges, which do not quite reach the centre of the sucker and thus leave here a circular depression (fig. 20). When killed with a hot solution of corrosive sublimate, the whole body, but especially the posterior portion, strongly curves towards the ventrum. This is due to the strong development of the longitudinal muscular fibres of the ventral side; and even in specimens killed under the pressure of a cover-slip, it is rare to prevent the curvature of the hind part of the body and to obtain fully the ventral aspect of the sucker. The latter is provided with one pair of strong hooks situated on either side of the centre. Each hook consists of a flattened basal portion and a recurved claw-like distal portion, and is hollow for the greater part. The basal portion has a thick process on one side. These hooks attach the worm so tenaciously to the substratum that the distal claw-like portion mostly breaks off in

the attempt to clean off the fragments of the tissue of the host. In connection with the sucker there are numerous unicellular glands in the posterior part of the body free from the genital organs. They are of various size and form according to the stages of secretory activity (fig. 22). The smaller ones are irregularly polyhedral and measure about $20\ \mu$ or less in diameter; the nuclei are very small and the cytoplasm is very finely granular, and has a strong affinity for stains. In this stage no distinct membrane could be observed. The larger gland cells are mostly of a globular shape, and the nuclei are large. There is a thin but distinct external membrane, the cytoplasm is coarsely granular and has less affinity for stains. There are also some spacious vacuoles of irregular form. These larger gland cells always send out large ducts, which form a bundle on either side of the body, and proceeding backwards, finally open, each bundle by itself, near the hind border of the sucker. The smaller cells above described are evidently gland cells in the interval of secretory activity, and the contents of the vacuoles in the larger cells are the mucus.

Along the antero-lateral borders of the body there are openings of numerous mucous glands, which impart a dark aspect to this portion. These glands are unicellular and goblet-shaped. The cell bodies lie at some distance from the external margin of the body, and contain either a finely or a somewhat coarsely granular cytoplasm according to the stages of secretory activity. The finely granular cytoplasm stains more deeply than the coarsely granular, but not very deeply after all. The nuclei are always very small and lie near the periphery. The ducts are very long, and open on the ventral side of the body close to the margin (figs. 19 & 24).

The mouth is situated at a short distance from the front end of the body, and leads directly into the cavity of the pharynx. The latter is drum-shaped, and along its anterior margin there are nine openings of the glands situated in its wall. The oesophagus is exceedingly short, and into it open by long necks the numerous unicellular salivary glands situated between it and the margin of the body. The cytoplasm of these glands is coarsely granular and stains very deeply. The intestine divides into two main simple branches, which proceed backwards and unite with each other at a distance from the posterior end equal to about one-third of the total length of the body. The lumen of the intestine is lined by a one-layered epithelium consisting of flat cells with small nuclei and a finely granular, weakly staining cytoplasm (fig. 23). There appears to be neither circular nor longitudinal muscle fibres for the intestine.

There is only a single main excretory vessel on either side of the body, from which numerous branches start in all directions. Anteriorly, the main vessels of the two sides unite with each other on the dorsal side of the brain, just as in *Tristomum*, then again divide into two and ramify several times at the front end of the body. At the level of the oesophagus the main vessels are much dilated and open to the exterior, each by means of a rather long vessel, on the dorsal surface of the body. The terminal flame cells could be very distinctly observed.

Of the nervous system I have not been able to make out very much. The main arrangement is perfectly similar to that of most other species. The brain is situated directly in front of the pharynx and contains four eye-spots arranged in the corners of an isosceles trapezoid.

The ovary is an irregularly U-shaped body lying at the front end of the middle third of the body ; but the two arms of the U are so close to each other that the ovary appears roundish in surface view. The oviduct starts from the anterior end of the left arm of the U, and after proceeding for a short distance forwards receives the openings of the shell glands and becomes the ootyp. This is very spacious and is the direct continuation of the oviduct ; its anterior end nearly reaches the anterior intestinal arc, just behind which begins the uterus. The latter is a rather slender duct proceeding directly towards the left side of the body and opening into the genital atrium side by side with the seminal vesicle. The shell glands are very numerous and large, and their long necks are very prominent even in surface view. The vitellarium is very extensive and occupies more than the middle two-fourths of the body ; it is present not only in the lateral portions but also in the median portion enclosed by the main intestinal branches, where the lobes closely intermingle with one another. Each paired yolk duct is formed by the union of two ducts coming from the anterior and posterior portions, arising just in front of the ovary. The single yolk duct is exceedingly short and opens directly into the oviduct at about the middle of its length.

There are two roundish testes, nearly equal in size, in the median line of the body, one lying at some distance in front of the other, behind the ovary. The vas efferens of the anterior testis starts from its hind end and curves towards its left side, where it joins the duct coming from the posterior testis, which gives it off from its front end. The vas deferens proceeds forward on the left side of the anterior testis and the ovary, and passing on the dorsal side of the paired yolk duct of the left

side, proceeds anteriorly and, undergoing a few convolutions on the left side of the ootyp, opens into the vesicula seminalis. The terminal portion of the vas deferens is always somewhat enlarged in contradistinction to the next adjoining portion, which is exceedingly narrow. The seminal vesicle is a pear-shaped sac lying in the left angle between the pharynx and the anterior intestinal arc, with its smaller end directed posteriorly and opening into the genital atrium. The vas deferens opens into the seminal vesicle at its middle, on the inner side.

The genital atrium is a spindle-shaped, elongated cavity appearing like the direct continuation of the uterus, extending between the point of union of the uterus and seminal vesicle and the common genital pore. The latter lies on the ventral side, close to the lateral margin, in the constriction dividing the anterior glandular portion of the body from the rest. I call it the genital atrium, because it appears to be lined by a membrane closely similar to the investing membrane of the body. The porus genitalis communis is exceedingly small.

There is no vagina.

Habitat.—Gill of a sucking-fish (*Remora brachyptera*).

Loc.—Newport, R. I.

The present species combines the characters of several genera. In its general aspect it somewhat resembles *Fridellicianella ovicola* Brandes ['94], but is distinguished by the absence of the vagina ("Seitenwulst" of Brandes*). It resembles *Phyllonella* in having two testes and the mucous glands at the anterior end

* If I may put on my own interpretation to the observations of another, I may state here that, in my opinion, the duct regarded by Brandes as the genito-intestinal canal is not so, but must be a true vagina corresponding to that of the *Gyrodactylidae* in general, to which, as the author thinks, the species must be reckoned, and opening on the "Seitenwulst." My statement in the text is based on this opinion.

of the body, but again differs from it in the absence of the vagina and several other characters. In short, the present genus appears to me to combine several of the characters of the *Gyrodactylidae* and the *Monocotylidae*.

In conclusion it may be useful to formulate the diagnoses of the new genus.

“Body flat and elongated ; with a single posterior sucker, the inner surface of which is divided by radial ridges into ten areas, with one pair of chitinous hooks. Mouth at a short distance from the front end ; intestine bifurcated, simple. With four eye-spots. Porus genitalis communis submarginal. Testes two, one lying in front of the other. No vagina.”



Literature cited.

- Bell, F. J.
 '91. Description of a New Species of *Tristomum* from *Histiophorus brevirostris*. *Ann. Mag. Nat. Hist.*, Ser. 6, Vol. VII.
- Bettendorf, H.
 '97. Ueber Muskulatur und Sinneszellen der Trematoden. *Zool. Jahrb.* Abthl. f. Anat. u. Ontog., Bd. 10.
- Brandes, G.
 '94. *Fridellicianella ovicola*, n. g. u. sp. Ein neuer monogenetische, Trematod. *Abhandl. d. naturforsch. Gesellsch. zu Halle*, Bd. 20.
- Cunningham, J. T.
 '90. A Treatise on the Common Sole.
- Dujardin, F.
 '45. Histoire naturelle des helminthes ou vers intestinaux.
- Goto, S.
 '94. Studies on the Ectoparasitic Trematodes of Japan. *Journ. Coll. Sc.*, Imp. Univ., Tokyo, Vol. VIII.
- Kuhn, J.
 '29. Description d'un nouveau genre de l'ordre des Douves.....Mém. du Mus. d'Hist. Nat., T. XVIII. [Not accessible to the writer.]
- Leidy, J.
 '88. Entozoa of the Terrapin. *Proc. Acad. Nat. Sc. Philadelphia*.
- Monticelli, F. S.
 '88. Saggio di una morfologia dei trematodi.
 '90. Note elmintologiche. *Boll. Soc. Naturalisti Napoli*, Ser. I, Vol. 4.
 '91. Di alcuni organi di tatto nei tristomidi. Contributo allo studio dei trematodi monogenetici. Parte I. *Boll. Soc. Nat. Napoli*, Ser. I, Vol. V.
 '99. Il genere *Acanthocotyle*. *Archives de Parasitologie*, T. II.
- Parona, C. e Perugia, A.
 '89. Res ligustice. VIII. Di alcuni trematodi ectoparassiti di pesci marini. Nota preventiva. *Ann. Mus. Civ. St. Nat. Genova*, Ser. 2, Vol. VII.
 '92. Note sopra trematodi ectoparassiti. *Ann. Mus. Civ. St. Nat. Genova*, Vol. XII. [Not accessible to the writer.]
 '96. Sopra due nuovi specie di trematodi parassiti delle branchie del Brama Rayi. *Boll. Mus. Zool. Anat. Comp. R. Univ. Genova*.
- Saint-Remy, G.
 '98. Complément du synopsis des Trématodes monogénèses. *Arch. d. Parasitologie*, T. I.

Setti, E.

- '98. *Tristomum* Perugiai n. sp. sulle branchie del *Tetrapturus belone* Raf.
Archives de Parasitologie, T. I.
'99. Contributo per una revisione dei Tristomi. Atti della Società Ligustica di Scienze Natuali e Geografiche, Vol. X.

Van Beneden, P. J.

- '56. Note sur un Trématode nouveau du maigre d'Europe. Bull. Acad. Roy. Sc. Belgique, T. 23, 2me. part. [Not accessible to the writer.]
'61. Mémoire sur les vers intestinaux.

Van Bededen, P. J., et Hesse, C. E.

- '64. Recherches sur les Bdellodes et les Trématodes marins.

Verrill, A. E.

- '75. Brief Contributions to Zoology from the Museum of Yale College. No. 33. Results of Dredging Expeditions off the New England Coast in 1874.
'85. Annual Report of the Commissioner of Fish & Fisheries for 1883. Pl. 43.

Wright, R.R.

- '79. Contributions to American Helminthology; No. 1. Proc. Canad. Inst., New Series, Vol. I.

Explanation of Plates.

ABBREVIATIONS.

<i>app. post.</i>	posterior appendage.	<i>pen.</i>	penis.
<i>can. gen. int.</i>	canalis genito-intestinalis.	<i>phar.</i>	pharynx.
<i>chit.</i>	chitinous hooks or corpuscles.	<i>por. gen. com.</i>	common genital pore.
<i>det. vit.</i>	yolk duct.	<i>por. vag.</i>	vaginal pore.
<i>enceph.</i>	brain.	<i>rec. sem.</i>	seminal receptacle.
<i>gl. conch.</i>	shell gland.	<i>tes.</i>	testis.
<i>gl. muc.</i>	mucous gland.	<i>ut.</i>	uterus.
<i>gl. pros.</i>	prostate gland.	<i>vag.</i>	vagina.
<i>gl. sal.</i>	salivary gland.	<i>v. def.</i>	vas deferens.
<i>int.</i>	intestine.	<i>ves. ex.</i>	excretory vesicle (terminal).
<i>mus.</i>	musele.	<i>ves. sem.</i>	seminal vesicle.
<i>oot.</i>	ootyp.	<i>vit.</i>	vitellarium.
<i>ov.</i>	ovary.		

Plate XX.

Phyllonella hippoglossi.

- Fig. 1. Anterior end of the body. \times about 5.
 „ 2. Cross-section through the anterior part of the body. \times about 20.
 „ 3. Genital organs, with the exception of the vitellarium. \times 18.
 „ 4. Chitinous hooks of the posterior sucker. *a* anterior piece, *b* middle piece, *c* posterior piece, *d* chitinous granules. (Zeiss 2AA.)
 „ 5. Gigantic cells in the vicinity of the chitinous hooks of the posterior sucker. Zeiss 3 A.
 „ 6. Portion of a cross-section through the posterior sucker; to show the relation of the gigantic cells to the surrounding tissues. \times 250.
 „ 7. Ganglion cells of the posterior sucker and nerve plexus. Zeiss 1 D.

Epibdella sciaenae.

- „ 8. The whole animal in the ventral aspect; from a specimen in possession of Dr. Stiles of Washington. \times 7.
 „ 9. Chitinous hooks of the posterior sucker. The hooks are not in their natural relative position. \times 190.

Tristomum leve.

- „ 10. Chitinous corpuscles on the surface of *Tr. histiophori* Bell. \times 250.
 „ 11. Chitinous hook from the posterior sucker of *Tr. leve* Verrill. \times 54.
 „ 12. Chitinous hook from the posterior sucker of *Tr. histiophori* Bell. \times 54.

Hexacotyle thunninae.

- „ 13. The entire animal, from a specimen in possession of Dr. Stiles of Washington. There was an injury in the hind part of the body.
 „ 14. Chitinous armature of the posterior suckers. *a* the piece at the inner end, *b* the one in the middle, *c* the one at the outer end.
 „ 15. Chitinous hooks at the posterior end of the body. *a* inner hook, *b* outer hook. \times 270.

Plate XXI.

Polystomum Hassalli n. sp.

- „ 16. The entire animal in the ventral aspect. \times 61.
 „ 17. *a* larger hook at the posterior end of the adhesive disc, *b* hook in the posterior suckers. \times 190.

Polystomum oblongum of Leidy.

- „ 18. Penis hook. \times 200.

Dionchus Agassizi n. g. n. sp.

- „ 19. The entire animal in the ventral aspect. \times 54.
 „ 20. Ventral view of the posterior sucker.
 „ 21. Two views of the posterior hooks. \times 250.

- Fig. 22. Two gland cells from the posterior part of the body. $\times 389$.
,, 23. Cross-section of the intestine. $\times 389$.
,, 24. Portion of a cross-section through the anterior part of the body, to show the mucous glands. $\times 389$.

Acanthocotyle Verrilli n. sp.

- ,, 25. The entire animal viewed from the ventral side. $\times 32$.
,, 26. One of the chitinous corpuscles of the sucker. *a* basal portion, *b* distal portion. $\times 250$.

Microcotyle pomatomi n. sp.

- ,, 27. The entire animal viewed from the dorsal side. $\times 34$.

Microcotyle stenotomi n. sp.

- ,, 28. The entire animal viewed from the dorsal side. $\times 32$.

Microcotyle hiatulae n. sp.

- ,, 29. The entire animal viewed from the dorsal side. $\times 42$.

Microcotyle longicauda n. sp.

- ,, 30. The entire animal viewed from the dorsal side. $\times 31$.
,, 31. Atrial spines. $\times 146$.

